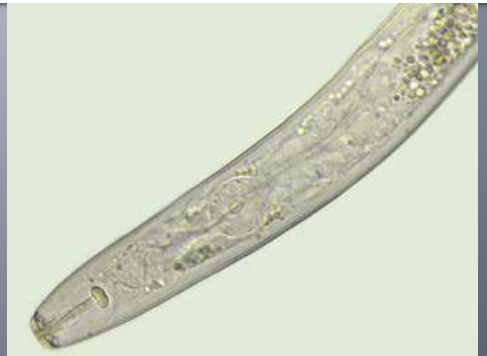
Meloidogyne



Meloidogyne

- Root knot nematodes are sedentary obligate endoparasites.
- They are distributed worldwide over a wide range of geographical conditions,
  - more prevalent in tropical and sub-tropical climatic zones.

Root Knot Nematode (Meloidogyne)

- Berkeley (1855) first reported the root knot disease in glasshouse grown cucumbers in England and named this nematode as "vibrios".
- Subsequently, many researchers identified and described many species.
- Chitwood (1949) accommodated root knot nematodes under the genus *Meloidogyne* Goeldi, 1982.

Genus name *Meloidogyne* was derived from Greek words which mean
"apple shaped female"

Meloidogyne from India

- In India, for the first time Barber (1901) reported RKN from tea plantation, Kerala
  - believed as first PPN reported from India.
- Subsequently Ayyar (1926) and many others reported infestation of root knot nematodes on number of vegetable crops.

Meloidogyne Diversity

- Globally, there are 101 described species in the genus.
- Among identified *Meloidogyne* spp. the four major species that cause vast crop damage -
  - *M. incognita* (Kofoid and White 1919)
  - *M. javanica* (Treub 1885)
  - *M. arenaria* (Neal, 1889) and
  - *M. hapla* (Chitwood, 1949)

- In India, fourteen species of root knot nematodes are recorded.
  - Among them, M. incognita and *M. javanica* are widely distributed in different parts of the country.
- In addition to direct injury and migration, *Meloidogyne* acts as predisposing and facilitating agent for the entry of soil borne fungal and bacterial pathogens.

- *M. incognita* is the single most crops damaging pathogen in the world which is responsible for $100 billion annual economic loss globally.

- Considerably, this polyphagous pest reported to cause an average 10% yield losses in vegetables crops and in highly susceptible crops such as tomato, eggplant and melons it is reported to cause 30% of yield loss.

Classification

Phylum : Nematoda Potts, 1932

Class : Chromadorea Inglis, 1983

Subclass : Chromadoria Pearse, 1942

Order : Rhabditida Chitwood, 1933

Suborder : Tylenchina Thorne, 1949

Infraorder : Tylenchomorpha De Ley & Blaxter, 2002

Superfamily : Tylenchoidea Örley, 1880

Family : Meloidogynidae Skarbilovich, 1959

Subfamily : Meloidogyninae Skarbilovich, 1959

Genus : Meloidogyne Goeldi, 1892

Principal Species

- Common, economically important and of worldwide distribution-
  - *M. arenaria, M. hapla, M. incognita, M. javanica,. M. chitwoodi, M. ethiopica, M. fallax, M. graminicola, M.acronea, M. enterolobii , M. exegua, M. paranaensis*

- *Of which 4 more are major RKN*
  - *M. arenaria, M. hapla, M. incognita, M. javanica*

PARASITISM AND LIFE CYCLE

- Female lays 400-500 eggs into gelatinous matrix generally protrude out of the host (egg mass).
  - Gelatinous matrix is glycoprotein complex produced from female rectal glands; act as protective agent against environmental extremes and predation.
- Egg undergoes embryogenesis and proceeds to
  - 1st stage juvenile which moults to infective second stage juvenile.
- Motile second stage infective juvenile moves freely in soil in search of suitable host.
- Juveniles able to survive without hosts for several months by utilizing its stored reserved food
  - i.e. glycogen and glycolipid.

Life cycle contd.....

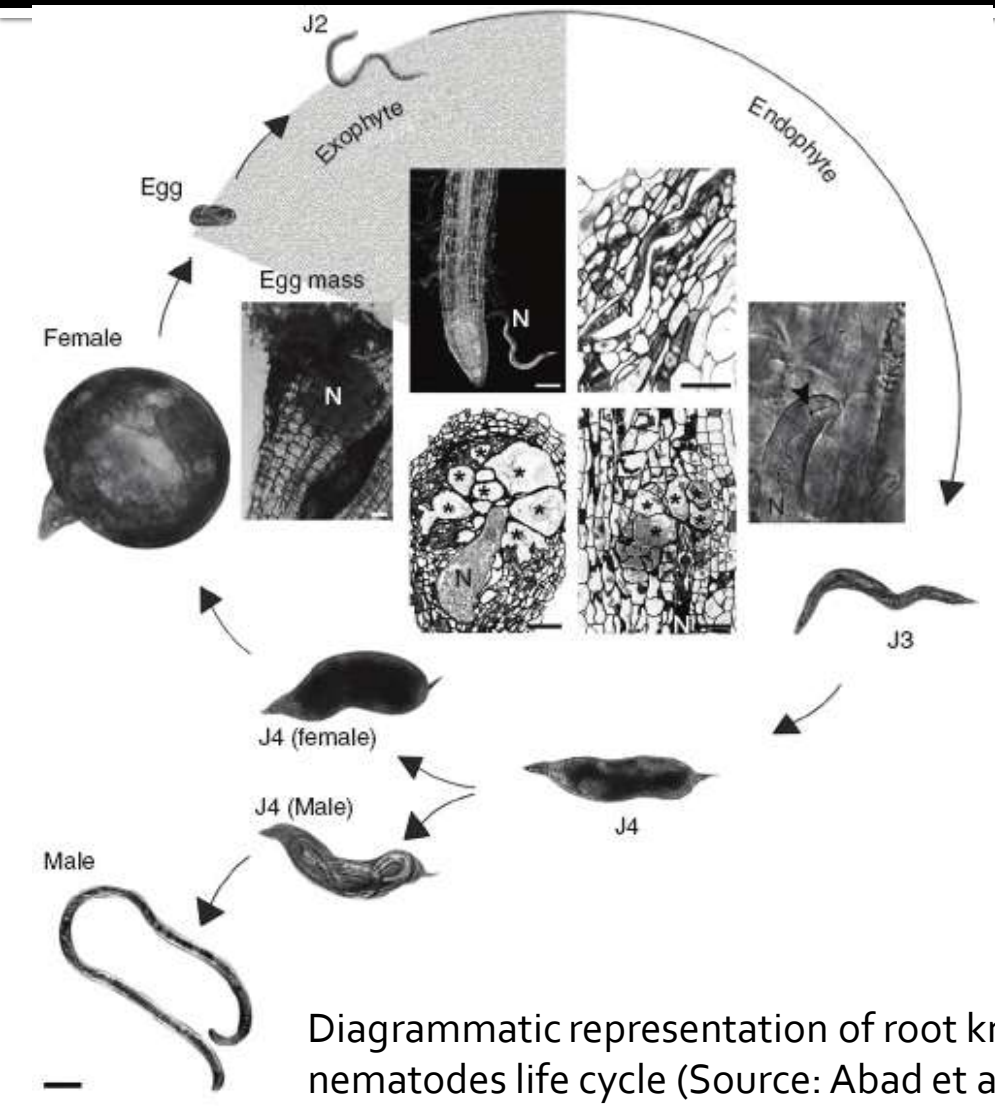
- Plant cell contents get liquefied and semidigested through its oesophageal secretion containing hydrolyting enzymes.
  - Enzymes also induce excessive conversion of **tryptophan** into **indole acetic acid** resulting in enlargement and coalescing of pericycle cells leads to development of multinucleate giant cells.
  - cortical parenchymatous tissue in around giant cells undergo excessive multiplication leads to development of tiny swellings or galls on the roots and several of these galls merge in to big multiple galls.
  - Giant cells serve as the permanent food source for nematode development and reproduction.

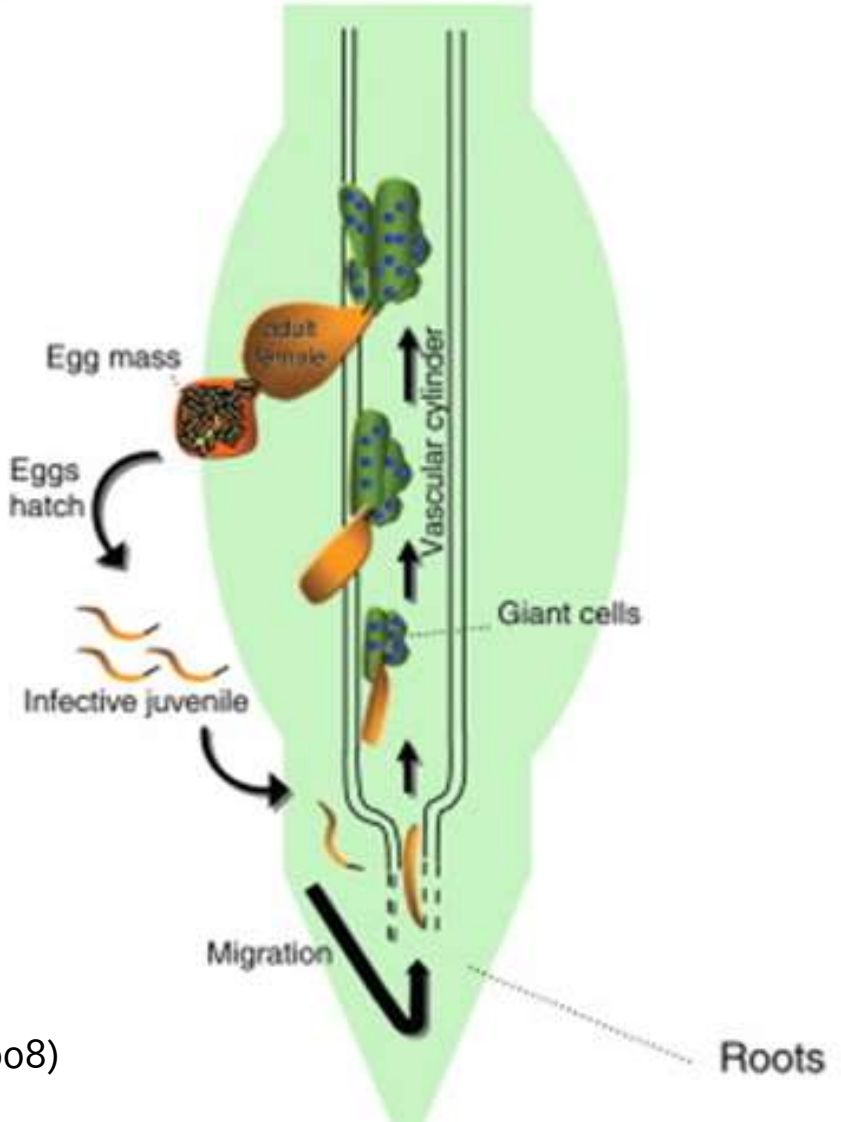
Life Cycle contd....

- Post infection, second stage juveniles continuously feed for several weeks (2-3 weeks optimally) and undergo series of three moults in quick succession and further majority juveniles develop into pyriform sedentary females.

- **The total duration of life cycle is 3 to 4 weeks.**

Meloidogyne Life Cycle contd.....





Diagrammatic representation of root knot nematodes life cycle (Source: Abad et al., 2008)

HOST RANGE

- One or more species of root knot nematodes are known to infest nearly every crop responsible for the supply of world's food, fruits, vegetables, plantations, spices, fibre, resins and ornamentals crops.

- They are also reported to infest on 226 weed species belonging to 43 botanical families.

Host Range (in India)

- *M. incognita* and *M. javanica* have the widest host range infecting more than 232 and 114 genera of plants respectively.
- The most preferred hosts of RKN are -
  - vegetables, pulses, fibre crops, fruits, ornamentals, medicinal and aromatic plants and other important cash and 6 plantation crops.
  - *M. arenaria* is known to attack on 15 genera of plants including vegetables and is serious problem in groundnut crop.
  - In case of *M. hapla* which is limited to cooler regions and host range covers about 9 genera.

PHYSIOLOGICAL RACES OF ROOT KNOT NEMATODES

- Physiological races of root knot nematodes are known to occur in four prominent species of the RKN such as *M. incognita* and *M. javanica*, *M. arenaria* and *M. hapla*.
  - *M. incognita* : 4 races (race 1, 2, 3 & 4)
  - *M. javanica* : 3 races (race 1, 2 & 3)
  - *M. arenaria* : 1 race (race 2)

- Identification of races is an essential requirement before developing nematode resistance cultivars against the target population of any RKN species.

Economic Loss due to RKN

- Solanaceous Vegetables -
  - **Economic loss**: Tomato- 11-35%; Brinjal- 10-42%; Chilli- 8-23%.
- Cucurbitaceous Vegetables -
  - **Economic loss**: Cucumber- 6-18%, Bottle gourd- 21-23% Snake gourd- 17% Bitter gourd- 13-14% Pumpkin- 13%.
- Okra
  - **Economic loss**: 10-29%.
- Root Crops (Carrot, Radish)
  - **Economic loss**: Carrot: 18.20%

Meloidogyne on World map

Meloidogyne (below ground symptoms)

INTERACTION WITH SOIL BORNE PATHOGENS

- The root exudates from root knot infected plants stimulate the entry of soil borne pathogens and aggravate the problem still further leading to development of disease complex and causing **40-70% severe losses** in vegetable crops in the country.

- In addition, RKN also breaks the resistance in cultivars which are resistant to soil borne fungal and bacterial pathogens.

RKN association in the development of major disease complexes in vegetable crops

Disease complexes	RKN spp.	Associated Pathogenic spp.	Vegetable crops
Damping off	*M. incognita*	*Rhizoctonia solani*	Tomato
Collar rot	*M. incognita*	*Sclerotium rolfsii*	Brinjal
Bacterial wilt	*M. incognita*	*Ralstonia (Pseudomonas) solanacearum*	Tomato
Soft rot	*M. incognita*	*Pectobacterium carotovorum subsp. carotovorum*	Carrot
Fusarium wilt	*M. incognita*	*Fusarium oxysporum f. sp. lycopersici*	Tomato
Fusarium wilt	*M. incognita*	*Fusarium oxysporum f. sp. conglutinans*	Cauliflower
Damping- off	*M. javanica*	*Pythium debaryanum*	Tomato

DIAGNOSTICS OF RKN

- Cuticular markings surrounding the vulva and anus (posterior pattern or perineal pattern) of *Meloidogyne* female is used for species identification as mentioned-

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- ***Meloidogyne incognita***
  - Striae are smooth, wavy, sometimes in a zigzag pattern.
  - Lateral lines absent.
  - Squarish high dorsal arch containing a distinct whorl around the tail terminus.

- ***Meloidogyne javanica***
  - Striae are smooth and somewhat wavy.
  - Unique distinct lateral lines or ridges run across the pattern and fading away around the tail terminus.
  - Dorsal arch often low and rounded, sometimes high and squarish, frequently possessing a whorl in the tail terminus area.

DIAGNOSTICS OF RKN

- *Meloidogyne arenaria*
  - Striae are smooth and slightly wavy, often extended laterally, forming wings on one or both lateral sides of the pattern.
  - Distinctive lateral ridges are absent, but pattern marked by forked, irregular lateral fields.
  - Dorsal arch low and indented near the lateral fields, forming rounded shoulders.
- *Meloidogyne hapla*
  - Striae are close, smooth and wavy, some patterns form wings on one or both lateral sides.
  - Region of perineal pattern between anus and tail terminus stippled with subcuticular punctuations.
  - Lateral ridges absent but the lateral fields marked by irregularities in the striae.
  - Dorsal arch usually low and rounded, but may be high and squarish.

ECOLOGY AND SEASONAL DYNAMICS

- Different stages of root knot nematodes and their activities highly influenced by abiotic and biotic factors.
- Temperature, moisture and soil type are most important abiotic factors influencing the distribution, life cycle, survival and pathogenicity.
- Three prominent species *M. incognita*, *M. arenaria* and *M. javanica* need 25-30°C temperature for multiplication and survival
  - Hence dominant in tropical and subtropical region of the world.
- *M. hapla multipky and survive at* 0 - 15°C or above.
  - Hence dominant in temperate and sub temperate regions

- In northern plains of India, peak populations of RKN and severe damage in vegetable crops generally observed during September/October months and March/April months.

- The length of the life cycle depends on temperature which varies from 28-30 days at optimum temperature, while in the winter season it may extend > 50 days.

INTEGRATED NEMATODE MANAGEMENT (INM)

- Once the root knot nematodes are established in vegetable field, it is virtually impossible to eradicate. However the population of RKN may be minimized. The Objectives of INM is-
  - To minimize environmental and health hazards.
  - Utilization of several compatible measures.
  - To maximize natural environmental resistance to plant parasitic nematodes.
  - To minimize the use of drastic control measures.
  - To increase reliance on location specific and resource compatible management strategy.
  - To minimize input costs in harmony with potential gains and maximize profit to the concerned grower.

COMPONENTS OF INTEGRATED NEMATODE MANAGEMENT

- **Cultural methods**: Summer ploughing, crop rotations, antagonistic crops, trap crops, destructions of crop residues, applications of organic amendments, use of resistant varieties/hybrids/genotypes .
- **Biological control**: Use of nematode antagonist biocontrol agents
- **Physical methods**: Soil sterilization and steam sterilization
- **Chemical methods**: Need based application of granular or systemic nematicides.

Chemical Managment

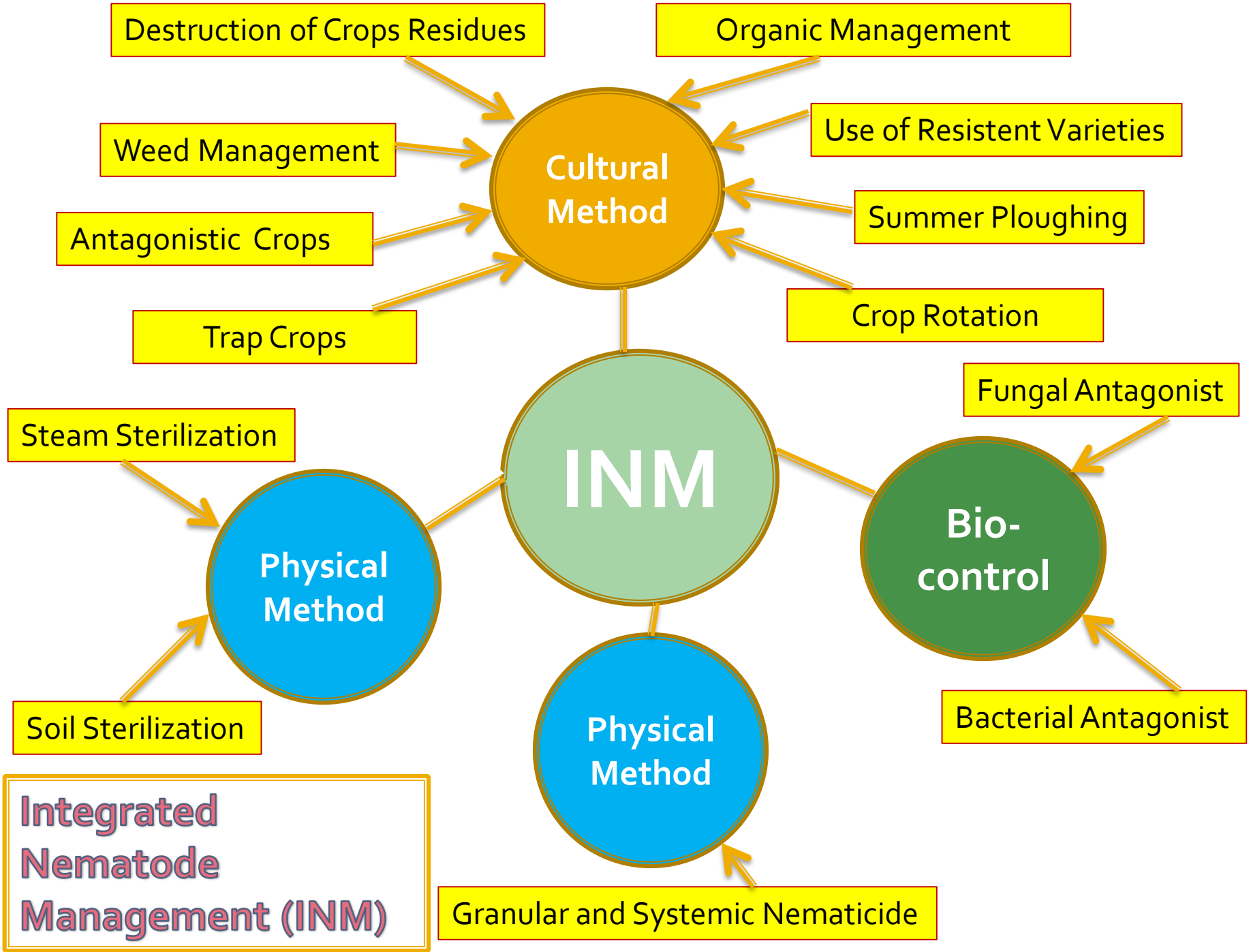
- Use of Nematicide at the time of transplantation of crop
  - E.g. Carbofuran (Furadon), Ethoprophos (Mocap), Prorat (Thimet)
- Treatment of soil after harvest of the crop

Chemically Treated and Untreated Roots

Dazomet treated

Metham sodium treated

Untreated


Destruction of Crops Residues
Organic Management
Weed Management
Use of Resistent Varieties
Cultural Method
Antagonistic Crops
Summer Ploughing
Trap Crops
Crop Rotation
Fungal Antagonist
Steam Sterilization
INM
Physical Method
Bio-control
Soil Sterilization
Physical Method
Bacterial Antagonist
Granular and Systemic Nematicide
Integrated Nematode Management (INM)

Thanks